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TECHNICAL MEMORANDUM ASRCE TM-63-15

COMPILATION OF GENERAL DYNAMICS | ASTRONAUTICS MATERIALS RESEARCH DATA

Prepared By
Materials Applications Division
Deputy/CMDR/Research Engineering

28 May 1963

Task 738103

Aeronautical Systems Division
Air Force Systems Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

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Technical Memorandum
ASRCE TM-63-15

Materials Applications Division
Air Force Materials Laboratory
Deputy/CMDR/Research Engineering

COMPILATION OF GENERAL DYNAMICS/ASTRONAUTICS MATERIALS RESEARCH DATA

I. PURPOSE:

To document the accomplishments under Contract AF33(616)-7984 with General Dynamics/Astronautics, San Diego, Calif.

II. FACTUAL DATA:

Appendix I describes the activity performed by General Dynamics/Astronautics under Contract AF33(616)-7984. Each materials report listed in Appendix II may be obtained from DDC(ASTIA) by providing the contract number and General Dynamics report number.

III. CONCLUSIONS: None

IV. RECOMMENDATIONS: None

COORDINATION:

EDWARD DUGGER, ASRCE-31

PREPARED BY:

GEORGE YOUNG

RICHARD KLINGER, ASRCE-31

PUBLICATION REVIEW

This report has been reviewed and is approved.

D. A. SHINN
Chief, Materials Information Branch
Materials Applications Division
AF Materials Laboratory

APPENDIX I

COMPILATION OF GENERAL DYNAMICS/ASTRONAUTICS MATERIALS RESEARCH DATA

Prepared for

DIRECTORATE OF MATERIALS AND PROCESSES

AERONAUTICAL SYSTEMS DIVISION

AIR FORCE COMMAND

WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Project No. 62-6899-7381, Task No. 738013

Prepared under Contract No. AF 33(616)-7984 by

GENERAL DYNAMICS/ASTRONAUTICS, San Diego, California

FOREWARD

This report was prepared by General Dynamics/Astronautics, a Division of General Dynamics Corporation, under Contract No. AF 33(616)-7984. This contract was initiated under Project No. 62-6899-7381, Task No. 738103, "Data Collection and Correlation." The work was administered under the direction of the Directorate of Materials and Processes, Deputy for Technology, Aeronautical Systems Division, with Mr. R. F. Klinger and Mr. G. C. Young acting as project engineers.

The program at General Dynamics/Astronautics was performed under the direction of Dr. H. F. Dunholter, Director of Research and Development, Dr. V. A. Babits, Manager of Research, and Mr. A. Hurlich, Chief of Materials and Structures Research, with Mr. A. F. Hooper acting as the Astronautics project engineer.

This report covers the work performed during the period from 1 March 1961 to 27 May 1963.

The author wishes to acknowledge the assistance of his associates who contributed to this program and, in particular, the contributions of Mr. J. E. Chafey, Mr. T. T. Tanalski and Mr. A. Hurlich, who supplied technical counsel throughout the course of the program.

This report was written as General Dynamics/Astronautics Report GD/A 63-0034.

ABSTRACT

Contract AF 33(616)-7984 required General Dynamics/Astronautics to furnish the Aeronautical Systems Division with hitherto unpublished materials properties data which had been developed in connection with company-sponsored materials research studies, and in connection with aerospace vehicle research, development and production programs. By "hitherto unpublished" was meant data which had not been published in the open literature, or which had not been incorporated into reports which were widely disseminated to government agencies and other aerospace companies. Reports prepared for internal distribution within General Dyanmics/Astronautics fell into this category, as did materials test data which were kept in the form of standard test reports, workbooks, or other unassembled form.

The materials properties information was provided to the Aeronautical Systems Division and to various agencies, stipulated by the contract monitor, by means of reports; some of which presented data in the form of graphs and tables summarizing the results of many tests, and some in the form of complete technical reports covering particular test programs. The Phase I portion of the contract covered the reporting of materials properties data described above. The Phase II portion of the contract included brief descriptions of the status, objectives, results, and conclusions of materials research studies underway at General Dynamics/Astronautics during the contractual period. Many of these company-sponsored programs were completed during the contractual period and reports covering these studies were furnished to the Aeronautical Systems Division.

INTRODUCTION

The materials research data compilation program was authorized and funded by the Directorate of Materials and Processes, Aeronautical Systems Division, Air Force Command at Wright-Patterson Air Force Base, Ohio, under Contract No. AF 33(616)-7984, during the period 1 March 1961 through 27 May 1963.

The purpose of the program was to review and distribute all unpublished aerospace materials research data generated by General Dynamics/Astronautics during the period 1956 through the first two months of 1963. The materials research data compilation program was one of many such programs contracted by the Directorate of Materials and Processes, Aeronautical Systems Division, to obtain all significant unpublished technical information on the mechanical and physical properties of materials which was available throughout the aerospace industry. The reports generated by the program were furnished at the request of the contract monitor to various government agencies and scientific personnel working on the same or similar problems within the aerospace industry.

The materials research data tabulated and distributed under Contract AF 33(616)-7984, by General Dynamics/Astronautics, were extracted from reports prepared for internal distribution within the company, from data tabulated on standard test forms, from workbooks, and other sources where they existed in more or less unassembled form.

COMPILATION PROGRAM

Approximately seven hundred and fifty (750) individual test reports, generated from November 1957 to the present by the Materials Research, Structures, Materials Test Laboratories, and the Materials and Processes Groups at General Dynamics/Astronautics, have been screened. Some one hundred and nine (109) individual reports containing pertinent mechanical and physical properties data which were considered to be sufficiently documented and reliable enough for inclusion in the data compilation program have been reproduced for distribution. In many instances, reports gave incomplete information on the chemical composition, heat treatment or other thermal and mechanical processing applied to the material, or else insufficient information on the details of test specimens or test procedures. In all such cases, the materials properties data were not incorporated into the reports sent to the Aeronautical Systems Division, since they were considered unreliable.

The reports incorporated under Phase I Quarterly Progress Reports, 1 March 1961 through 27 May 1963, are listed in the Appendix II. The Phase II semi-annual progress reports listed in the Appendix II presented the status of the company-sponsored materials research program during the period of 1 March 1961 through 27 May 1963.

RECOMMENDATIONS

Rapid advances have been made in many fields of science under the stimulus of major aerospace vehicle development programs. It is no exaggeration to say that as much or more materials research effort is expended in connection with aerospace vehicle and hardware development and production programs as under contracted studies concerned directly with materials research and development.

While contracts concerned with aerospace vehicle development generally require the contractor facilities to provide reports on structural, dynamic, systems, ground and flight tests, they rarely specify that materials evaluation and development tests conducted in support of hardware development programs be reported upon.

It is recommended that all aerospace vehicle and hardware contracts awarded by government agencies stipulate requirements for the preparation and distribution of technical reports covering materials tests performed in support of the end item developments. The dissemination of materials properties data and information so generated will be of major value to the entire industry and could, in many cases, result in considerable economies through the elimination of excessive duplication in the area of materials testing.

SUMMARY

During the materials research data compilation program under Contract AF 33(616)-7984 from 1 March 1961 through 27 May 1963, General Dynamics/ Astronautics reviewed all of the available unpublished aerospace materials data and distributed the pertinent mechanical and physical properties data previously recorded. Therefore, General Dynamics/Astronautics will not consider re-negotiation for continuance of the contract for the fiscal year of 1963-64.

APPENDIX II

List of Reports Summarized or Provided Under Phase I

First Quarterly Progress Report - 1 March 1961 to 1 June 1961

GD/A Report No. AE62-0138-1

GD/A Report No.	Title
MRG-162	Thermal Conductivity of Plastic Foams from -320°F to 75°F, 14 June 1960.
MRG-187	Cross-Tension and Shear Spot Weld Tests on AM 355 CRT Material, 27 September 1960.
MRG-195	Effects of Sheet Thickness on the Mechanical Properties of Type 301 EFH Stainless Steel at Cryogenic Temperatures, 30 November 1960.
MRG-196	Evaluation of the Room Temperature Mechanical Properties of Hy-Tuf, SAE 4340 and SAE 4160 Steels as Heavy Duty Spring Materials, 1 December 1960.
MRG-202	Thermal Conductivity of Various Insulations from -320°F to 75°F, 28 December 1960.
MRG-205	Evaluation of Heat-Treated SAE 4160 Steel as Heavy-Duty Spring Material, 9 January 1961.
MRG-208	Mechanical Properties of Off-Chemistry 301 XFH Stainless Steel Sheet. Specification 0-71004, Heat No. 32786, 0.010" Thick, 10 January 1961.
MRG-213	Mechanical Properties of Titanium Alloy Sheet, Ti-5Al-2.5Sn, at Room Temperature and Cryogenic Temperatures, 1 February 1961.
MRG-214	Review of Data Pertaining to Application of 301 CRES and 310 CRES in the CENTAUR Vehicle, 7 February 1961.
MRG-219	The Susceptibility of Materials to Hydrogen Embrittlement from Chemical Milling Operations, 16 March 1961.
MRG-222	An Investigation of the Deterioration and Swelling Effects of Several Radiation Packaging Greases, 17 April 1961.

List of Reports Summarized or Provided Under Phase I

Second Quarterly Progress Report - 1 June 1961 to 1 September 1961
GD/A Report No. AE62-0138-2

GD/A Report No.	Title
MRG-112	Mechanical Properties of AM 355 Alloy at 78°F in Various Conditions of Heat Treatment, 24 November 1959.
MRG-116	Tensile Properties of AM 355 Alloy After Sub-Zero Cooling and Tempering and Double Aging, 16 December 1959.
MRG-120	Tensile Testing of Conolon 506 at Room and Sub-Zero Temperatures, 16 December 1959.
MRG-142	Mechanical Properties of AM 355 Alloy at -320°F in Various Conditions of Heat Treatment, 15 March 1960.
MRG-147	Room Temperature Mechanical Properties of AM 350 Alloy Heat-Treated by a Double Aging Temperature, 1 April 1960.
MRG-150	Mechanical Properties of Inconel-X Sheet at +78°, -100°, -320° and -423°F, 20 April 1960.
MRG-156	Resistance Spot Welding of Aged A-286 to Type 301 EFH Stainless Steel, 16 May 1960.
MRG-157	Mechanical Properties of Heat Treated A-286 Alloy at Various Testing Temperatures, 8 June 1960.
MRG-246	Mechanical Properties of Ti-8Al-1Mo-2V Alloy at Room and Cryogenic Temperatures, 2 August 1961.
MRG-249	Mechanical Properties of Annealed Commercially Pure Titanium Sheet, AMS 4901, (Ti-75A), 4 August 1961.

Third Quarterly Progress Report - 1 September 1961 to 1 December 1961

ERR-AN-002	The Effect of Cryogenic Temperatures on the Mechanical Properties and Transformation Characteristics of High Strength Sheet Alloys (Non-Ferrous), 13 April 1960.
ERR-AN-003	The Effect of Cryogenic Temperatures on the Mechanical Properties and Transformation Characteristics of High Strength Sheet Alloys - Cold Worked Austenitic Stainless Steels, 16 May 1960.
ERR-AN-032	Cryogenic Adhesive Evaluation Study, 26 January 1961.

List of Reports Summarized or Provided Under Phase I (Continued)

GD/A Report No.	Title
ERR-AN-055	Measurement of the Elastic Properties of 300 Series Stainless Steels at Cryogenic Temperature by Ultrasonic Techniques, 24 April 1961.
ERR-AN-057	A Study of Austenite Decomposition at Cryogenic Temperatures, 9 June 1961.
ERR-AN-067	A Study of Deformational Mechanisms in Ductile Ceramics, July 1961.
ERR-AN-085	A Study of the Effects of Nuclear Radiation on High-Strength Aerospace Vehicle Materials at the Boiling Point of Hydrogen (-423°F), 27 September 1961.

Fourth Quarterly Progress Report - 1 December 1961 to 1 February 1962

GD/A Report No. AE62-0138-3

MRG-154	Measured Values for the Coefficients of Linear Expansion of Polycel 420 and Conolon 506 at Low Temperatures, 3 May 1960.
MRG-160	Final Report on the Evaluation of Chemical Milling as a Possible Process Technique in the Production of 1/2 Hard and 3/4 Hard 301 Stainless Steel Bulkheads, 8 June 1960.
MRG-164	Properties of R-41 Sheet, A Vacuum Melted, Nickel Base Alloy, 14 June 1960.
MRG-189	Mechanical Properties of Titanium and Titanium Alloys at Cryogenic Temperatures, 14 October 1960.
MRG-190	Mechanical Properties of Aluminum Alloys at Cryogenic Temperatures, 2 December 1960.
MRG-191	Mechanical Properties of Cold-Rolled Commercially Pure Titanium Sheet, AMS 4901 (Ti-75A), 4 October 1960.
MRG-209	Materials Selection for the RIFT Vehicle, 13 January 1960.
MRG-211	X-Ray Diffraction Substantiation of Magne-Gage Determinations of Martensite Composition in 301 Stainless Steel, 8 February 1961.
MRG-226	The Cryogenic Tensile Properties of Cold Worked 20% and 25% Nickel Steels, 9 May 1961.

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Fourth Quarterly Progress Report - 1 December 1961 to 1 February 1962
GD/A Report No. AE62-0138-3 (Continued)

GD/A Report No.	Title
MRG-237	Tensile Testing of Adlock 851, Adlock PG-LA, and Adlock EG-11A-81A from -423°F, to 78°F, 22 June 1961.
MRG-250	Influence of Creep Damage on the Toughness of Ti-5Al-2.5Sn and 301 Stainless Steel XFH at -423°F, 17 August 1961.
MRG-266	Determination of the Effect of Oxygen Content on the Mechanical Properties of Titanium - - 5Al-2.5Sn Alloy at Room and Cryogenic Temperatures, 20 October 1961.

First Quarterly Progress Report - 1 June 1962 to 1 September 1962

Supplement 2 to Contract AF 33(616)-7984

MRG-134	Evaluation of Inconel-X to 301 Stainless Steel Resistance Spot Weld at 78°F and -423°F, 18 February 1960.
MRG-244	The Influence of Boiling Temperature on the Cryogenic Properties of Type 300 Series Stainless Steel, 12 February 1961.
MRG-247	The Elevated Temperature Properties of Type 301 EFH Stainless Steel, Ti-5Al-2.5Sn (A110AT) and Ti-12V-11Cr-3Al (B120VCA), 14 August 1961.
MRG-262	Determination of the Effects of Iron and Oxygen Contents on the Mechanical Properties of Titanium-5Al-2.5Sn Alloy Sheet at Liquid Hydrogen Temperature, 5 October 1961.
MRG-269	The Effects of Cyclic Loading on the Elevated Temperature Properties of Type 301 EFH Stainless Steel, Ti-5Al-2.5Sn (A110AT) and Ti-13V-11Cr-3Al (B120VCA) Alloys, 31 October 1961.
MRG-286	An Introduction to Crack Propagation in High Strength Sheet Materials, 2 February 1962.
MRG-288	Evaluation of Electroformed Nickel to 301 Stainless Steel Resistance Spot Welds at 78°F and -423°F, 25 January 1962.
MRG-293	The Effects of Cold Rolling on the Notched and Unnotched Tensile Properties of Type 310 Stainless Steel at 78°F, -320°F and -423°F, 9 February 1962.
MRG-298	Mechanical Properties of Type 202 Stainless Steel at Cryogenic Temperatures, 9 March 1962.

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First Quarterly Progress Report - 1 June 1962 to 1 September 1962
Supplement 2 to Contract AF 33(616)-7984 (Continued)

GD/A Report No.	Title
MRG-300	Mechanical Properties of Hastelloy Sheet Alloy R-235 at Cryogenic Temperatures, 19 March 1962.
MRG-307	Mechanical Properties of Air Melted and Consutrode Melted Type 302 Stainless Steel at Room and Cryogenic Temperatures, 4 April 1962.

Second Quarterly Progress Report - 1 September 1962 to 1 December 1962

Supplement 2 to Contract AF 33(616)-7984

MRG-152	The Effects of Tempering Time on the Tensile Properties of AM 355 Alloy, 29 April 1960.
MRG-275	Cast Foam Insulation Evaluation, 21 November 1961.
MRG-278	Titanium for Cryogenic Propellant Tankage, 21 November 1961.
MRG-297	Mechanical Properties of Several 2000 and 6000 Series Aluminum Alloys at Cryogenic Temperatures, 6 March 1962.
MRG-309	Interim Report on the Mechanical Properties of Electro-formed Nickel at Room and Cryogenic Temperatures, 6 April 1962.
MRG-312	Thirty Day Evaluation of Foams and Honeycomb for CENTAUR Intermediate Bulkhead, 26 April 1962.
MRG-316	Second Interim Report on the Mechanical Properties of Electro-formed Nickel at Room and Cryogenic Temperatures, May 1962.
MRG-319	Third Interim Report on the Mechanical Properties of Electro-formed Nickel at Room and Cryogenic Temperatures, June 1962.
MRG-323	Thermal Conductivity and Coefficient of Expansion of Fiber-glass Honeycomb Panels at Low Temperatures, 26 June 1962.
MRG-328	Mechanical Properties of Cold Rolled Commercially Pure Titanium Sheet AMS 4902 (Ti-45A), 19 July 1962.
AR-592-1-329	The Effects of Cold Rolling on the Mechanical Properties of Type 310 Stainless Steel at Room and Cryogenic Temperatures, 23 July 1962.
AR-592-1-331	Determination of Hydrogen Embrittlement Susceptibility of Chem-Milled Type 301 EFH Stainless Steel, 26 July 1962.

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Second Quarterly Progress Report - 1 September 1962 to 1 December 1962
Supplement 2 to Contract AF 33(616)-7984 (Continued)

GD/A Report No.	Title
AR-592-1-333	Evaluation of Composite Insulations for CENTAUR F-Z Liquid Hydrogen Tank, 26 July 1962.
AR-592-1-334	Evaluation of RIFT Insulation Test Program, 17 August 1962.
AR-592-1-335	The Tensile and Shear Properties of Several Solders at Cryogenic Temperatures, 17 August 1962.
AR-592-1-351	Revised Design Allowables for 301 XFH for Use in the ATLAS Mk II Program, 24 September 1962.

Third Quarterly Progress Report - 1 December 1962 to 1 March 1963

Supplement 2 to Contract AF 33(616)-7984

MRG-176	Tensile Properties of AM 355 CRT Steel at 400°F, 17 August 1960.
MRG-192	Selection of Materials for Saturn Vehicle (S-II), 30 September 1960.
MRG-238	Properties of AM 355 for Use in Ultra-Lightweight Tankage for Storable Liquid Propellants Missile Systems, 7 July 1961.
MRG-326	Testing of Fiberglass Honeycomb Cores in Support of a CENTAUR Non-Vacuum Type Bulkhead Design, 2 July 1962.
AR-592-1-358	The Effects of Nickel Foil on the Strength of Resistance Welds in Type 301 Stainless Steel at Room and Cryogenic Temperatures, 18 October 1962.
AR-592-1-364	Comparison of 181-225 and 181-150 Glass Cloths, 19 November 1962.
AR-592-1-365	The Effects of Cold Rolling on the Mechanical Properties of Type 310 Stainless Steel at Room and Cryogenic Temperatures, 27 November 1962.
AR-592-1-373	Mechanical Properties of Titanium 5Al-2.5Sn Alloy at Room and Cryogenic Temperatures, 10 December 1962.
AR-592-1-375	Evaluation of 2017-T4, 2117-T4 and 5056-H32 Aluminum Alloys at Cryogenic Temperatures, 17 December 1962.
ERR-AN-255	Mechanical Properties of High-Strength Sheet Materials at Cryogenic Temperatures, 28 November 1962.

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Fourth Quarterly Progress Report - 1 March 1963 to 27 May 1963

GD/A Report No.	Title
MRG-123	Effects of Very Low Temperatures (to -423°F) on Rubber Cushioned Clamps (MS Z1919 (ASG) and Teflon Cushioned Clamps (CVA Std. 81-45900), 4 January 1960.
MRG-132-1	Selection of Materials for Cryogenic Application in Missiles and Aerospace Vehicles, 25 February 1960.
MRG-149	Directionality Effects in Cold Rolled 301 CRES, 18 April 1960.
MRG-204	Quantitative Analysis of Nickel-Iron Alloys by Use of the X-Ray Spectrometer, 19 January 1961.
MRG-233	Effects of Combined Environments on Structural Materials in a Nuclear Rocket, 14 June 1961.
MRG-242	Thermal Conductivity of Plastic Foams from -423°F to 75°F, 25 July 1961.
MRG-276	Study of Adhesives for Insulation Panels, 28 November 1961.
MRG-281	Organic Film for Repair of Leaks through Cracked Spot Welds, 4 January 1962.
MRG-289	Detection of Cracks Adjacent to Spot Welds by Radiography in Thin Stainless Steel Sheet, 29 January 1962.
MRG-296	Sonic Fatigue Testing of Beryllium Components in the KIWI Reactor, 27 February 1962.
MRG-299	Compatibility of CENTAUR/SURVEYOR Materials with Freon-12/ Ethylene Oxide Sterilant Gases, 13 March 1962.
MRG-303	The Effect of Heat Forming on the Thermal Conductivity of Polyurethane Foams, 27 March 1962.
MRG-317	Evaluation of Repairs for Cracked Spot Welds Applicable to CENTAUR Intermediate Bulkheads, 18 May 1962.
MRG-327	Thermal Characteristics of Fiberglass Honeycombs at Low Temperatures, 9 July 1962.
AR-592-1-372	The Feasibility of Using a Non-Metallic for Foaming of Vertistat Rods, 10 December 1962.
AR-592-1-374	Metallographic Examination of Radiographically Detected Defects in Resistance Spot Welds in .010" Thick 301 Stainless Steel CENTAUR Intermediate Bulkheads, 11 December 1962.

GENERAL DYNAMICS/ASTRONAUTICS

Fourth Quarterly Progress Report - 1 March 1963 to 27 May 1963 (Continued)

GD/A Report No.	Title
AR-592-1-383	Evaluation of Heliarc Weld Repair of Resistance Spot Welds in Type 301 Stainless Steel, 12 February 1963.
AR-592-1-412	The Effect of Nickel Foil on the Strength of Resistance Welds in the Type 301 Stainless Steel at Room and Cryogenic Temperatures (Final Report), 25 March 1963.
AR-592-1-415	The Effect of Cryogenic Temperatures on the Mechanical Properties of Reinforced Plastic Laminates, 27 March 1963.
AR-592-1-424	Investigation of Effects of Parting Agent on Bond Strengths, AC-2 Insulation, 9 April 1963.
AR-592-1-432	Comparison of Cross-Tension and Shear Strengths of Heliarc and Resistance Spot Welds in Type 301 Stainless Steel at Room and Cryogenic Temperatures, 19 April 1963.
AR-592-1-434	Interpretation of Radiograph Images of Resistance Spot Welds in Type 301 Stainless Steel, 22 April 1963.
AR-592-1-439	Fracture Toughness Testing of One Heat of Titanium 5Al-2.5Sn, 24 April 1963.
7E-681	Welded Joints, Stainless Steel 301 and 301(N) Comparison Properties of, 24 October 1958.
7E-697 (56-718)	Heli-Arc Spot Weld Efficiency Static Tests, 24 May 1957.
7E-1263	CRES Type 301 and 321 Stainless Steel Sheet, Poisson's Ratio at Ambient Temperatures, 5 June 1958.
7E-2379	Joint Design Allowables for CRES 301 Material at Room and -423°F Temperature, 20 May 1960.
27E-351	Tensile Static and Fatigue Properties of Tank 731-9B Lap Joints, 10 May 1960.
27E-1336	Compressive Strength of Conolon 506 at +75°F and -320°F, 11 January 1962.
27E-1376	Compression Stress-Strain Evaluation of Type 301 CRES Steel Sheet (Mil-S-5059) at Ambient Temperature, 6 March 1962.
55E-154	Properties of 321 Stainless Steel Joints at Room Temperature and -423°F, 25 September 1961.
55E-389	Evaluation of Joints Fabricated from CRES 310, 15 April 1960

List of Phase II Semi-Annual Progress Reports Under

Contract AF 33(616)-7984

1 March 1961 to 1 March 1962

GD/A Report No.	Title
AE62-0060	First Summary Report - Phase II, 1 March 1961 to 1 September 1961.
AE62-0060-1	Second Summary Report - Phase II, 1 September 1961 to 1 March 1962.

Phase II Semi-Annual Progress Report

Under Contract AF 33(616)-7984, Supplement 2

1 June 1962 to 27 May 1963

AE62-0942	First Summary Report - Phase II, 1 June 1962 to 1 December 1962.
GDA63-0217	Second Summary Report - Phase II, 1 December 1962 to 27 May 1963.